Acid-Base Equilibria – Strong versus Weak Titration Assignment

1. 25.0 mL of standardized 0.45 mol/L NaOH is titrated with 0.35 mol/L acetic acid. Assume the *K*a of acetic acid is 1.8 × 10-5.

a. Calculate the pH of the NaOH before any acetic acid has been added.

b. Calculate how much acetic acid must be added to reach the equivalence point.

c. Calculate the pH at the equivalence point.

d. Calculate the pH after 21 mL of acetic acid has been added.

2. 24.0 mL of 0.39 mol/L acetic acid is titrated with a standardized 0.33 mol/L KOH solution. Assume the *K*a of acetic acid is 1.8 × 10-5.

a. Calculate the pH of the acetic acid before any KOH has been added.

b. Calculate how much KOH must be added to reach the equivalence point.

c. Calculate the pH if 50.0 mL of KOH is added to the acetic acid.

3. A standardized solution of potassium hydroxide is prepared by dissolving 2.54 g of dessicated (extremely dried out) KOH in distilled H2O and then brought to a volume of 2.50 x 102 mL. The solution is used to titrate a 35.0 mL sample of formic acid (HCHO2, *K*a = 1.8 × 10-4).

a. What is the pH of the titrant.

b. It takes 81.2 mL to reach the equilibrium point. What is the concentration of formic acid?

c. What is the pH at the equilibrium point? Does this make sense? Why?

4. A student is interested to know how much ammonia is present in a sample of Windex. They prepare a standardized solution of hydrochloric acid by diluting 82.5 mL of pure HCl (12.1 M) in distilled-deionized water and bringing the volume up to 1.00 L. 10.0 mL of that solution is then diluted again into distilled-deionized water and the volume is brought up to 100. mL. Using this solution, they titrate a small, 25.0 mL sample of windex. After the addition of 6.3 mL of titrant, the endpoint is reached.

a. What is the concentration of the HCl used as the titrant?

b. What is the concentration of ammonia in the Windex?

c. What would the pH of Windex be (if ammonia is the only pH altering substance in it)?

d. What is the pH at the endpoint?

e. What indicator could be used?

5. A toilet boil cleaner contains a certain concentration of hydrochloric acid. A student interested in learning how concentrated the acid is pours 50. mL of the cleaner into a bowl, and sprinkles in some baking soda (sodium bicarbonate). After adding 13.4 g, the acid is completely neutralized.

a. What is the concentration of HCl in the cleaner?

b. What is the pH of the cleaner?

c. What is the pH at the equilibrium point?

d. Without an indicator, how would the student know that the acid had been completely neutralized?

6. Hydrogen cyanide is a chemical compound with chemical formula HCN. A solution of hydrogen cyanide in water is called hydrocyanic acid. Hydrogen cyanide is a colorless, very poisonous, and highly volatile liquid that boils slightly above room temperature at 26 °C (78.8 °F). HCN has a faint, bitter, almond-like odor that some people are unable to detect due to a genetic trait. Hydrogen cyanide is weakly acidic and partly ionizes in solution to give the cyanide anion, CN–.

Cyanide is used in tempering steel, dyeing, explosives, engraving, the production of acrylic resin plastic, and other organic chemical products.

Fruits that have a pit, such as cherries and apricots, bitter almonds and apples, from which almond oil and flavoring are made, contain small amounts of cyanohydrins. Such molecules slowly release hydrogen cyanide.

100 g of apple seeds are crushed, and the pulp soaked in 50.0 mL of ddH2O (dd = distilled & deionized). The resulting solution is titrated with a standardized sodium hydroxide solution with a concentration of 8.8 × 10-3 M. The end point of the titration is reached after the addition of 42.0 mL of the titrant.

a. What is the mass of hydrogen cyanide in 100 g of apple seeds?

b. What would the pH of the extracted hydrocyanic acid be?

c. What is the pH at the endpoint?